REMARKS

Claims 1, 2, 4-8 and 10-12 are pending in this application. By this Amendment, claims 1, 4 and 8 are currently amended and claim 3 is canceled.

Entry of the amendments is proper under 37 CFR §1.116 since the amendments: (a) place the application in condition for allowance (for the reasons discussed herein); (b) do not raise any new issue requiring further search and/or consideration (since the amendments amplify issues previously discussed throughout prosecution); (c) do not present any additional claims without canceling a corresponding number of finally rejected claims; and (d) place the application in better form for appeal, should an appeal be necessary. The amendments are necessary and were not earlier presented because they are made in response to arguments raised in the final rejection. Entry of the amendments is thus respectfully requested.

The courtesies extended to Applicant's representative by Examiner Cygan at the interview held May 7, are appreciated. The reasons presented at the interview as warranting favorable action are incorporated into the remarks below and constitute Applicants' record of the interview.

I. CLAIMS 8 AND 10-12 DEFINE PATENTABLE SUBJECT MATTER

The Office Action rejects claims 8 and 10-12 under 35 U.S.C. §102(b) over WO 90/12277 to Bielle. This rejection is respectfully traversed.

Bielle does not disclose "a manipulated variable calculation means for scanning the surface of the workpiece by the displacement detecting means and for calculating a center locus, an inclination of the surface of the workpiece, of a series of at least three measurement data based on a scanned displacement signal," as recited in claim 8.

One object of the claimed invention is to provide a leveling device achieving highly accurate measurement (page 2, lines 6-11).

To achieve such object, the claimed invention according to claim 8 employs the following arrangement as shown in Fig. 10 of the present application, in which a stage 71 for holding a workpiece 17 thereon is supported at a fulcrum A and a point of action B. The angle of the stage 71 is adjusted by vertically moving the point of action B using a micrometer head 70.

The movement distance of the point of action B is determined as follows:

1) Calculating an inclination adjustment reference position P shown in Fig 13(B) of the present application in advance corresponding to the point of action B, when the inclination line C of the upper surface of the stage 71 is parallel with the base line N of moving means 62 (page 19, lines 14-27);

2) Calculating a center locus M shown in Fig. 11 of the present application in measuring the surface of the workpiece 17 (page 17, lines 33-34);

3) Measuring inclination amount between the center locus M and the base line N (page 20, lines 11-12); and

4) Obtaining an operation amount of length required to parallel those M and N (page 20, line 13), the operation amount being constantly given as an absolute quantity from the inclination adjustment reference position P (page 19, lines 10-13).

Without the above method, when the inclination line C of the stage 71 shown in Fig 12 of the present application is not parallel to the base line N, inclination adjustment error will be caused (page 19, lines 3-13). Specifically, as described at page 18, line 23 to page 19, line 13 and shown in Fig. 12 of the present application, when the initial inclination angle of the stage 71 (i.e., the inclination line C) is parallel to the base line N and the angle of the center locus M relative to the base line N is $\theta 1$, the accurate operation amount $\Delta h = r*\sin\theta 1$. Here, "r" represents a distance from the fulcrum A of the stage 71 to the point of action B.

On the other hand, when the inclination line C of the stage 71 is not parallel to the base line N but is rising in the right direction relative to the base line N, the turn angle thereof can be represented as θ2 as shown in Fig. 12. When the stage 71 is manipulated for Δh from a position remote from the base line N, the stage is manipulated at a steeper position for an angle away from the base line N as compared to manipulation for Δh from a horizontal position, so that θ2 becomes smaller than θ1 (θ1>θ2).

Accordingly, when the initial inclination angle of the stage 71 is not parallel to the base line N, the relationship between the operation amount and the turn angle cannot be uniformly decided, thus causing inclination adjustment error.

Thus, in the claimed invention, a position of the point of action B where the inclination line C connecting the fulcrum A and the point of action B of the stage 71 of the leveling device 60 is parallel with the base line N of the moving means 62 is set as the inclination adjustment reference position P and the operation amount is defined as an absolute quantity from the inclination adjustment reference position P, so that such error can be avoided.

Since the operation amount is not given as a relative quantity but is constantly given as an absolute quantity from the inclination adjustment reference position P, the inclination adjustment error can be avoided.

Bielle

Bielle has three supports 130 as described in page 10, lines 6 to 23. Two of the three supports are illustrated in the attached Fig. A-1.

According to Bielle's arrangement, displacement values at supporting positions X1 and X2 are measured by a touch sensor to calculate difference Δd therebetween. Then, the support at X1 is lifted by the difference Δd. Alternatively, the support at X2 is fallen by the difference Δd. Accordingly, inclination of the workpiece can be adjusted.

Distinction between the Claimed Invention and Bielle

The claimed invention uses the center locus M to calculate the inclination of the workpiece, while Bielle only calculates the difference between the displacement values of the two supports.

According to Bielle's arrangement, when the workpiece is small as shown in the attached Fig. A-2, the inclination of the workpiece cannot be adjusted, since the displacement value at X2 cannot be measured by the touch sensor.

Further, according to Bielle's arrangement, when the workpiece is bumpy as shown in the attached Fig. A-3, the adjustment of the inclination is largely influenced in accordance with the measurement points. Specifically, when the touch sensor contacts the ridge of the workpiece at X1 and the valley of the workpiece at X2 (Fig. A-3), the difference between the two points is calculated as R1 to adjust the inclination as shown in the attached Fig. A-4, even though the workpiece is horizontal (parallel with the reference triangle). As a result, the inclination is adjusted as shown in the attached Fig. A-5, in which R2 is larger than R1 (R2>R1).

On the other hand, according to the claimed invention, measurement points (horizontal measurement range) can be selected in accordance with the workpiece and the inclination of the workpiece is calculated based on the center locus M, such problems will not occur.

To achieve the above feature, the claimed invention calculates the inclination amount between the centre locus M and the base line N, and then obtains the operation amount of length based on the inclination amount.

On the other hand, in Bielle, only the difference Δd of length is calculated to adjust the inclination of the workpiece, even though Fig. 10 of Bielle shows inclination "α" to be adjusted.

Item 7 of the Office Action asserts that the reference triangle of Bielle corresponds to the center locus M of the present invention. This assertion is respectfully traversed. The center locus is "an inclination of the surface of the workpiece" prior to inclination adjustment (claim 8, 3rd paragraph), not the desired reference position. Further, as shown in Fig 11 of the present application, the word "center" locus means a "middle" line of measurement values, which is obtained by least square method, for example.

Instead, the reference triangle of Bielle is used for comparing itself with measurement values (Fig. 10 of Bielle) and only two points are used to adjust the inclination. The reference triangle of Bielle is clearly different from the center locus M of the present invention. Bielle only calculates the difference of length, even though Fig. 10 of Bielle shows the angle "α". Bielle is clearly different from the arrangement of the claimed invention in which inclination amount is calculated first and then the operation amount of length is obtained second based on the inclination amount.

The claimed invention is patentably distinct from Bielle. Bielle does not disclose or suggest calculation of "center locus" being an inclination of the surface of the workpiece. Further, Bielle does not disclose or suggest manipulated variable calculation means for calculating the center locus of a series of at least three measurement data to calculate an operation amount at the point of action relative to the fulcrum required for paralleling the center locus with the base line.

For at least these reasons, it is respectfully submitted that claim 8 is patentable over the applied reference. The dependent claims are likewise patentable over the applied reference for at least the reasons discussed as well as for the additional features they recite. Applicants respectfully request that the rejections under 35 U.S.C. §102(b) be withdrawn.

II. CLAIMS 1-7 DEFINE PATENTABLE SUBJECT MATTER

The Office Action rejects claims 1-7 under 35 U.S.C. §103(a) over JP 08-029153 to Fukuda et al. in view of Bielle. This rejection is respectfully traversed.

The applied references do not teach, disclose or suggest "determining a swivel correction amount (an operational amount of linear length for adjusting the swivel angle to zero degree) ... wherein the X-axis coordinates at the measurement start point and the measurement end point of actual measurement are arbitrarily set for adjusting orientation and workpiece scanning, ... and wherein each of the Y-axis adjustment means and the swivel adjustment means include a micrometer head, each micrometer head moving linearly," as recited in claim 1; and "calculating orientation of the workpiece from the positions to determine an inclination angle of the workpiece to the measurement direction to obtain an absolute quantity of an orientation correction amount (an operation amount of linear length for adjusting the inclination angle to zero degree) based on the inclination angle; ... wherein the positions of the workpiece at the measurement start point and the measurement end point of actual measurement are determined for adjusting orientation and workpiece scanning based on the edge line calculated by moving the workpiece in the Y-axis direction," as recited in claim 4.

A feature of the claimed invention is an arrangement in which measurement start point and measurement end point in adjusting relative inclination between the workpiece and measurement direction are the same with those start/end points of actual measurement.

Another feature of the present invention is an calculating an inclination value of the workpiece to obtain an operation amount of linear length, thereby correcting the inclination by a (linearly moving) micrometer head, which is similar to the argument for claim 8.

In the claimed invention, inclination of the workpiece is corrected as follows (see also page 13, line 5 to page 14, line 19 and Fig. 8 of the present application):

Inclination correcting step

1) Moving the sensor 24 in the X-axis direction to measurement start point (of actual measurement) (S120);

2) Moving Y-axis stage 12 back and forth to search Z-axis maximum value (S130) and input X-axis and Y-axis coordinates values at the time to the measurement controller 50 (S140);

3) Moving the sensor 24 in the X-axis direction to measurement end point (of the actual measurement) (S150);

4) Moving Y-axis stage 12 back and forth to search Z-axis maximum value (S160) and input X-axis and Y-axis coordinates values at the time to the measurement controller 50 (S170);

5) Calculating swivel inclination angle "δ" from the X-axis and Y-axis coordinates values at the measurement start point and the measurement end point to obtain the swivel correction amount "ds" (S180);

6) Linearly moving the swivel Digimatic micrometer head 42 to correct the inclination of the workpiece within the X-Y plane based on the swivel correction amount ds (S190);

Actual measurement step

7) Moving the sensor 24 to the measurement start point of the actual measurement (S200) and moving the Y-axis stage 12 back and forth to move the sensor 24 at a position where the Z-axis coordinates value is maximum (S210); and

8) Carrying out actual measurement (S220).

On the other hand, in Fukuda, inclination of the workpiece is corrected as follows (see also the following Fig. 10):

Inclination correcting step

1) Positioning the workpiece 17 on the rotating table 14 and moving the detector 24 in the X-axis direction three times (Y1 to Y3) to scan the workpiece ([0021] of Fukuda), while the detector 24 is relatively moved in the Y-axis direction by a linear movement mechanism 43 for moving the workpiece 17 in the Y-axis direction or other movement mechanism for moving the detector 24 in the Y-axis direction ([0022]);.

2) Calculating the direction of the ridgeline of the workpiece 17 relative to the X/Y/X-axes from a line connecting each point T1 (X1, Y1, Z1), T2 (X2, Y2, Z2) and T3 (X3, Y3, Z3) obtained by the three scans Y1 to Y3 ([0023]);

3) Calculating errors between the measured ridgeline direction (direction within X-Y plane and inclination relative to the X-Y plane) and the reference ridgeline direction by the error calculator 42B ([0024]);

4) Rotating the rotating table 14 in the θ direction, pivotally moving the R-axis table 13 and linearly moving the Y-axis table 12 in the Y-axis direction based on the output of the error calculator 52B to place the ridgeline of the workpiece 17 beneath the stylus 23 of the measurement mechanism 20 ([0025]); and

Actual measurement step

5) Carrying out actual measurement by moving the detector 24 in the X-axis direction ([0026]).

Distinction between the Claimed Invention and Fukuda

In the claimed invention, the measurement start point and the measurement end point in adjusting relative inclination between the workpiece and measurement direction are the same with those points of the actual measurement, which is not disclosed in Fukuda.

As implied in Fig. 3 of Fukuda, the measurement started/end points of the actual measurement (not temporary measurement) should be on the ridgeline of the workpiece 17.

However, Fukuda does not disclose that the measurement start/end points of the actual measurement correspond to some of the point T1, T2 and T3 obtained by the respective scans Y1 to Y3. According to Fukuda's method, the measurement start/end points of the actual measurement cannot be determined until correcting the inclination of the workpiece, since it is impossible to anticipate where each point T1, T2 and T3 corresponds to in the ridgeline of the workpiece 17.

Further, though Fukuda discloses the swivel angle correction by rotating the rotating table 14 ([0025]), Fukuda is silent as to how the rotating table 14 is rotated.

Accordingly, Fukuda discloses no arrangement in which rotation amount is calculated from an operation amount of linear length obtained based on the inclination amount.

Accordingly, Applicants respectfully submit that the rejection regarding the measurement start/end points (Item 5 of the Office Acton) has been overcome. As claimed, the measurement start/end points in adjusting the inclination are the same with those start/end points in actual measurement, as discussed above.

The Office Action asserts that Bielle teaches preprogrammed start and end points (Figs. 14 and 15). This assertion is respectfully traversed. These points are used only for the actual measurement, not for correcting the inclination of the workpiece.

Though the Examiner asserted during the interview that micrometer heads are common and obvious to one of ordinary skill in the art, we strongly traverse this assertion. As shown in the Applicants' Figs. 1 and 4, the claimed micrometer heads move linearly. To the contrary, swivel adjustment is rotation movement (movement in θ direction in the Applicants' Fig. 1). To connect both of the movements, the claimed invention uses a swivel angle (rotation angle) to calculate a swivel correction amount (linear length). Thus, it is not obvious to use the micrometer heads to correct the rotation angle as claimed.

The claimed invention according to claims 1-7 is clearly distinct from Fukuda and Bielle. Fukuda and Bielle do not disclose or suggest the X-axis coordinates input means for inputting X-axis coordinates at measurement start/end points of actual measurement in adjusting the orientation of the workpiece orientation adjustment stage. Further, the applied references do not suggest swivel correction amount of linear length determined based on a swivel angle and adjusted by a linearly moving micrometer head.

For at least these reasons, it is respectfully submitted that claims 1 and 4 are patentable over the applied references. The dependent claims are likewise patentable over the applied references for at least the reasons discussed as well as for the additional features they recite. Applicants respectfully request that the rejection under 35 U.S.C. §103(a) be withdrawn.

III. CONCLUSION

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1, 2, 4-8 and 10-12 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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JAO:RJK/mdw

Attachment:
Appendix

Date: June 9, 2003

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Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

APPENDIX

Fig. A-1

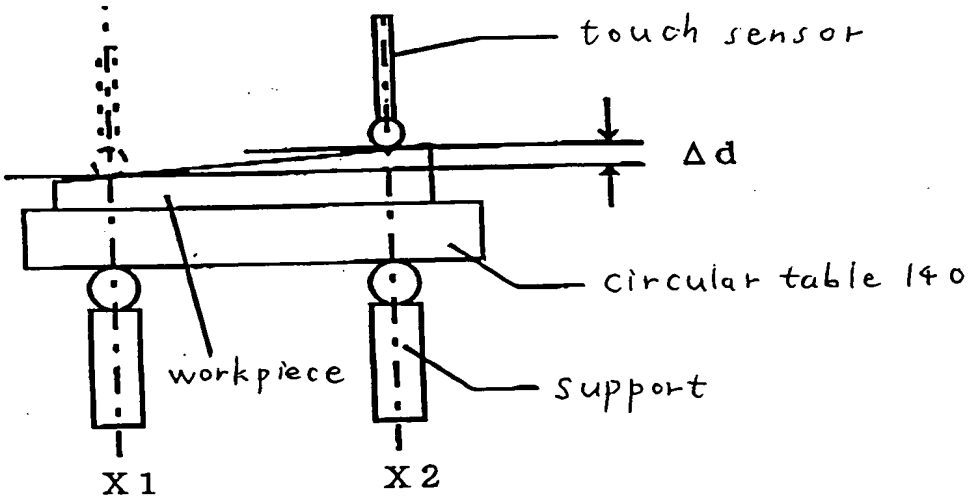

Fig. A-2

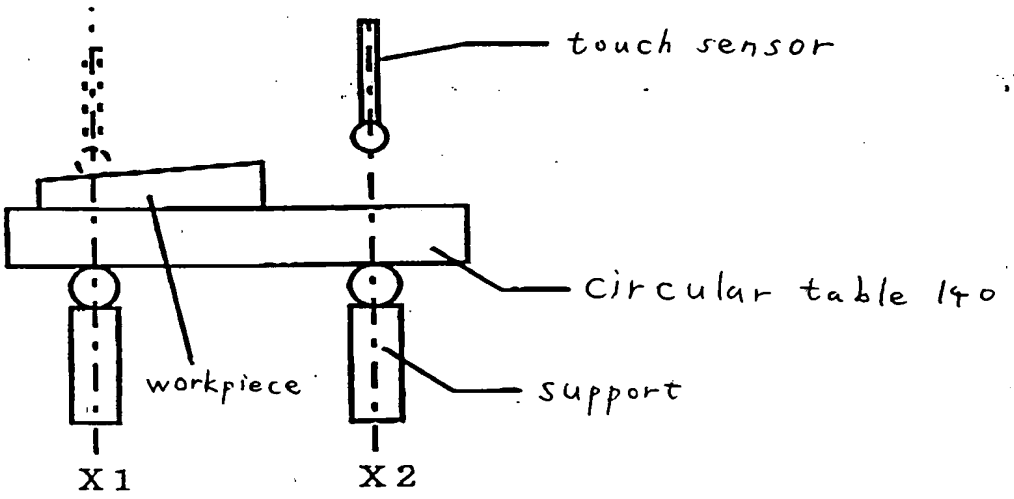

Fig. A-3

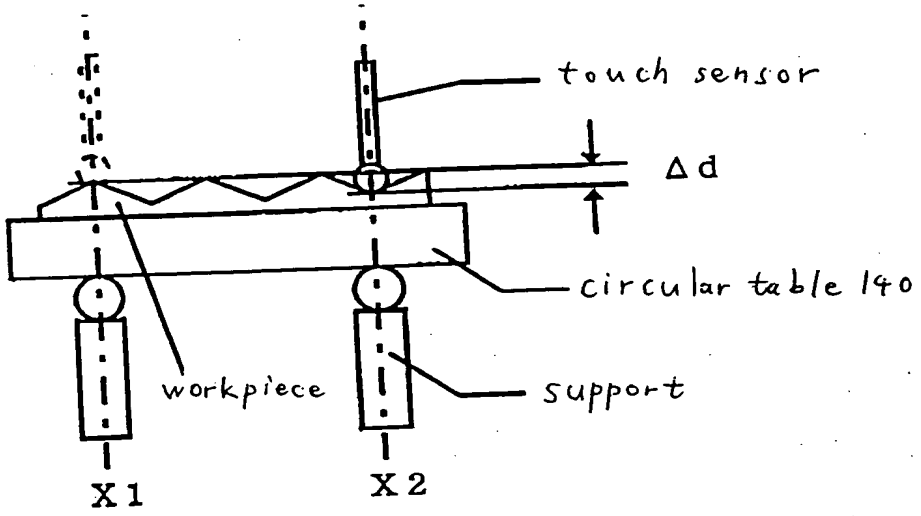

Fig. A-4

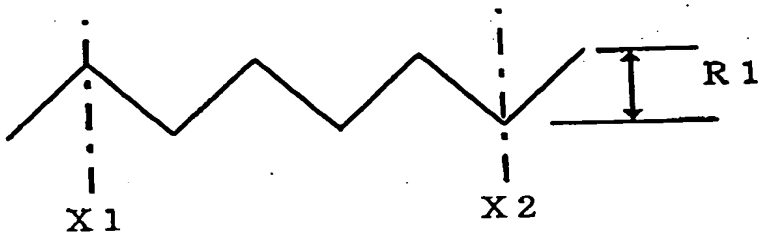
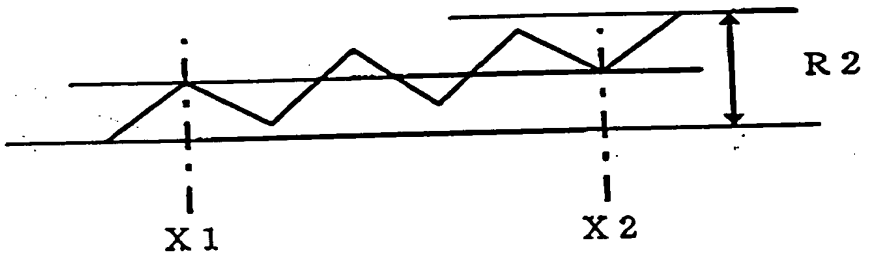
Fig. A-5